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7. The Role of AI in Monitoring and Diagnosing Capabilities

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ABSTRACT

The emerging and development of Artificial Intelligence (AI), especially deep learning, has stimulated its application in various engineering domains. Monitoring, diagnosis and prognosis, as the key elements of intelligence maintenance of manufacturing systems in the era of Industry 4.0, has also benefited from the advancement of AI technology. Artificial intelligence (AI) is defined as the capability of a machine to imitate intelligent human behavior in general. With a tremendous rise in computer capability the artificial intelligence by using various algorithms is helpful in helping medical experts for better diagnosis and treatment. Humans' mind first plans a goal and then requires AI to achieve this goal through supervised and unsupervised learning in this paper we will discuss The Role of AI in Monitoring and Diagnosing Capabilities.

KEYWORDS:

Monitoring, Diagnosing, Capabilities, Artificial Intelligence, Computer Capability, Algorithms, Treatment, Machine Learning, Healthcare Management, Medical Diagnostics, Deep Learning.

Introduction:

Computerized control systems that monitor, control, and diagnose process variables such as pressure, flow, and temperature have been implemented for various processes. When these systems are for large-scale processes, they generate many processes variable values, and operators often find it difficult to effectively monitor the process data, analyze current states, detect and diagnose process anomalies, and/or take appropriate actions to control the processes.

To assist plant operators, process operational information must be analyzed and presented in a manner that reflects the important underlying trends or events in the process. [1]

AI monitoring is also a necessary precondition to extracting meaningful business value from your models. Without understanding how your model's predictions are impacting downstream business KPIs and revenue, it's impossible to make further improvements and optimizations to your modeling pipeline. AI monitoring ensures that you are able to take preemptive actions before small modeling problems turn into catastrophic, system-level failures.

In medicine, artificial intelligence (AI) is being used more and more regularly, particularly in diagnosis and treatment planning. AI and machine learning have become effective diagnostic tools in recent years. By offering more accurate diagnoses, this technology can potentially change healthcare. Artificial intelligence facilitates healthcare management, automation, administration, and workflows in medical diagnostics. AI in medical diagnostics has demonstrated tremendous potential over the past several years in altering healthcare standards while easing medical services' intense pressures. [2]

Getting Started with AI Monitoring:

To get started with AI monitoring is easier than you might think. The first step is to define useful performance metrics that will guide your model development. These metrics should align with the business value that you hope to achieve from your ML model. They should also be closely monitored at a granular level, meaning that a model's performance based on the metric should be tracked relative to different segments of the data.

Effective metrics are easy to understand and compute while capturing the correct business behavior that is expected based on a model's predictions. For instance, in an ad recommendation system, a relevant metric would be a function comparing the different possible business results (such as ignore, click, conversion after click and perhaps even conversion size) to the confidence level the model had in choosing the specific ad. On the other hand, for a fraud detection model, a simpler metric would suffice, such as a mean squared error loss comparing how wrong your model was with its fraud confidence relative to an actual ground truth. [3]

Perhaps the biggest challenge faced by businesses looking to utilize AI solutions is getting stuck in the research mindset. This is natural as AI originally took root as a research discipline, and most of the advancements in the field arise out of academia or industry research labs. That said, staying in the research mindset can forestall effective action and the proper use of AI in a business setting. The better thing to do is to take a product-oriented approach where AI is viewed as a seamless integration into the business process and is evaluated based on its effects on concrete business measurements such as KPIs.

In this setting, collecting continuous feedback on your models' performance is key to developing a working AI system that achieves the desired business outcomes. This might mean setting up proxy feedback, such as human evaluations or confidence scores, for long-running processes where direct feedback from the system itself might not be immediately possible. It may very well also mean integrating monitoring into disparate systems that only occasionally interact, as sometimes the feedback that you need access to is siloed within a different platform or team.

AI in remote patient monitoring has ushered in a new era of personalized healthcare. AI algorithms can create individualized patient care and treatment plans by analyzing vast amounts of patient data, including medical history, vital signs, and lifestyle choices. These care plans consider each patient's unique characteristics. Thus, enabling healthcare providers to deliver tailored treatments and interventions. The result is enhanced patient satisfaction and more effective chronic care management.

Artificial Intelligence has brought together humans and machine where machines are able to mimic human actions intelligently. They understand human requests, analyze and connect data and draw apt conclusions. Machines automate analytical model using methods from statistics, neural networks, physics, and operation research to extract data insight without being programmed. [4]

Let's understand how machines are able to carry these tasks with their distinctive AI capabilities.

Capabilities of AI:

1. Machine Learning

Machine Learning is among the first subsets of AI that lets applications learn from data using mathematics and statistics. Algorithms of ML are not hardcoded to give out particular output. Rather, they are coded in a way that ingest data with labels and subsequently use the statistical models to find relationships within the large data that humans would find difficult to conceptualize.

2. Deep Learning

Deep Learning is the next advanced stage of Artificial Intelligence which makes use of huge Neural Networks with multiple layers of processing units. These advanced computing systems achieve improved training techniques using these networks and their layers to learn from huge and complex data patterns. Output activities of machines such as speech recognition and image recognition are some common Deep Learning results.

3. Computer Vision

AI capability that is based on Deep Learning and pattern recognition of picture and video data. These intelligent computing systems process, analyze and understand images by capturing real-time images or videos around them and interpreting their surroundings. Next time you use Augmented Reality features while shopping, ride a self-driving vehicle or get access to a secured area due to facial recognition security screening, you know it's because of the use of Computer Vision. Cardiac AI monitoring and diagnostics refers to the application of artificial intelligence (AI) technologies in the field of cardiology to monitor, analyze, and diagnose various cardiac conditions. AI algorithms are trained on large datasets of cardiac images, patient data, and clinical outcomes to develop models that can assist healthcare professionals in interpreting cardiac diagnostic tests and making treatment decisions. This emerging area of medical technology aims to improve the accuracy, efficiency, and accessibility of cardiac care.

Adoption of technology that will assist the process of medical diagnosis through automation, prediction, etc. is referred to as AI transformation in medical diagnosis. Recently, many technology firms are looking to create systems that reduce the time between tests and treatments.

This is done through automated and speedy mining of medical records with results of suggested treatments. Furthermore, there are predictive analytics platforms being developed, which uses machine learning to predict mortality. Within this technology, there are features that keep doctors in the loop with patient behavior, such as the patients that are likely to skip appointments and be irregular with their medication, their likelihood of readmission, risk of hospitalization, etc.

AI technology also allows patients to easily reach out to doctors for notification of new symptoms. Through machine learning and advanced algorithms, conditions can be detected at a rate that was previously considered impossible. [5]

Review of Literature:

A study by Ijaz et al. (2018) has used IoT for a healthcare monitoring system for diabetes and hypertension patients at home and used personal healthcare devices that perceive and estimate a persons' biomedical signals. The system can notify health personnel in real-time when patients experience emergencies. [6]

The AI techniques are also most efficient in identifying the diagnosis of different types of diseases. The presence of computerized reasoning (AI) as a method for improved medical services offers unprecedented occasions to recuperate patient and clinical group results, decrease costs, etc. The models used are not limited to computerization, such as providing patients, "family" (Musleh et al. 2019), and medical service experts for data creation and suggestions as well as disclosure of data for shared evaluation building. [7]

Detecting any irresistible ailment is nearly an afterward movement and forestalling its spread requires ongoing data and examination. Hence, acting rapidly with accurate data tosses a significant effect on the lives of individuals around the globe socially and financially. The best thing about applying AI in health care is to improve from gathering and processing valuable data to programming surgeon robots. This section expounds on the various techniques and applications of artificial intelligence, disease symptoms, diagnostics issues, and a framework for disease detection modelling using learning models and AI in healthcare applications (Kumar 2021). [8]

Computerized diagnostic decision support (DDS) tools emerged to alleviate the burden of data overload, enhance clinicians' decision-making capabilities, and standardize care delivery processes. DDS tools are a subcategory of clinical decision support (CDS) tools, with the distinction that DDS tools focus on diagnostic functions, whereas CDS tools more broadly can offer diagnostic, treatment, and/or prognostic recommendations. Most prominently, the capacity of data collection and the complexity of knowledge representation prevented accurate representation of the pathophysiological relationships between a disease and treatments. Programmed with a limited set of information and decision rules, several expert-based DDS tools could not generalize to all settings and cases.

Some suffered from performance issues as well, often struggling to generate a result or yielding an errant diagnosis. (Miller, 1994) [9]

Objectives:

- Improved diagnosis
- Reduced costs
- Pattern identification
- Clinically relevant, high quality and speedy data generation

Research Methodology:

The overall design of this study was exploratory. AI-based research should be conducted by keeping the flaw mentioned earlier in consideration to provide a mutually beneficial relationship between AI and clinicians. Sharing knowledge, resources, and information requires close cooperation between researchers, healthcare practitioners, data scientists, and technological specialists.

Such collaboration can make creating standardized protocols, regulations, and moral frameworks easier to ensure AI’s ethical and moral application in healthcare. We have directed this review according to the preferred reporting items for systematic reviews and Meta-Analysis guidelines. Moreover, growing initiatives by public and private firms for encouraging the adoption of AI-based diagnostic solutions are expected to fuel the expansion of the global artificial intelligence (AI) in diagnostics market. [10]

Result and Discussion:

Fault diagnosis plays an important role in exploring the relationship between measured data and machine health states, which has been the research hot-spot of Prognostics and Health Management PHM.

Traditionally, the relationship is found via expert knowledge and engineering experience. However, in engineering scenarios, people would like to shorten the maintenance cycle and improve the diagnostic accuracy through an automatic method. Especially with the help of AI, fault diagnosis is expected to become smart enough to automatically detect and identify health states.

Prognostics and Health Management (PHM) mainly consists of monitoring, diagnosis, prognosis, and health management, whose relationships are summarized in Figure 1. Monitoring refers to fault detection, and the purpose is to determine whether the system is in a normal operating state, in which anomaly detection is one of the most important tools to trace the corresponding health state.

Diagnosis refers to the identification of the fault type and its corresponding degree. In general, PHM will greatly improve the operational safety, system reliability, and maintainability of equipment, and reduce the cost of equipment throughout its life cycle at the same time.

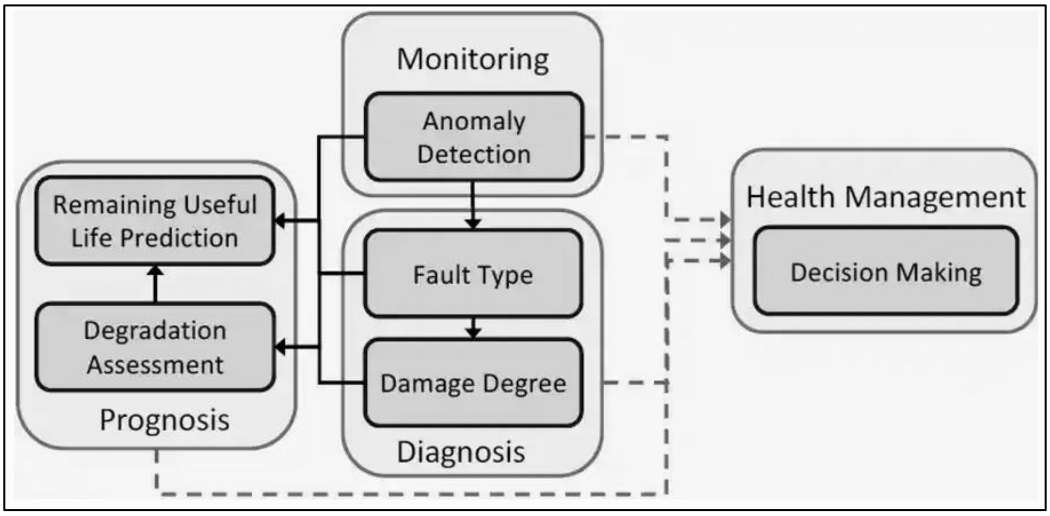

Figure 1: Relationship between monitoring, diagnosis, prognosis, and health management (Source: springeropen.com)

Electronic health records (EHRs), imaging technology, genetic data, and portable sensor data are just a few of the types of medical data being collected at a new level today. These numerous data may be processed and analyzed by AI algorithms, which can yield insightful information to help with medical diagnosis. AI algorithms can produce estimates and concepts by reviewing a patient's medical history, symptoms, testing results, and other relevant data.

Figure 2: Electronic health records (EHRs), imaging technology (Source: Scientific American)

AI algorithms for medical diagnosis rely extensively on machine learning (ML) approaches. Large datasets with labeled samples can be used to train ML systems to discover relationships and trends. The accuracy of the diagnosis is improved, and this comprehensive approach makes a more profound comprehension of complicated conditions possible.

Types of Artificial Intelligence:

Artificial Intelligence can be divided based on capabilities and functionalities. There are three types of Artificial Intelligence-based on capabilities -

- Narrow AI
- General AI
- Super AI

Under functionalities, we have four types of Artificial Intelligence -

- Reactive Machines
- Limited Theory
- Theory of Mind
- Self-awareness

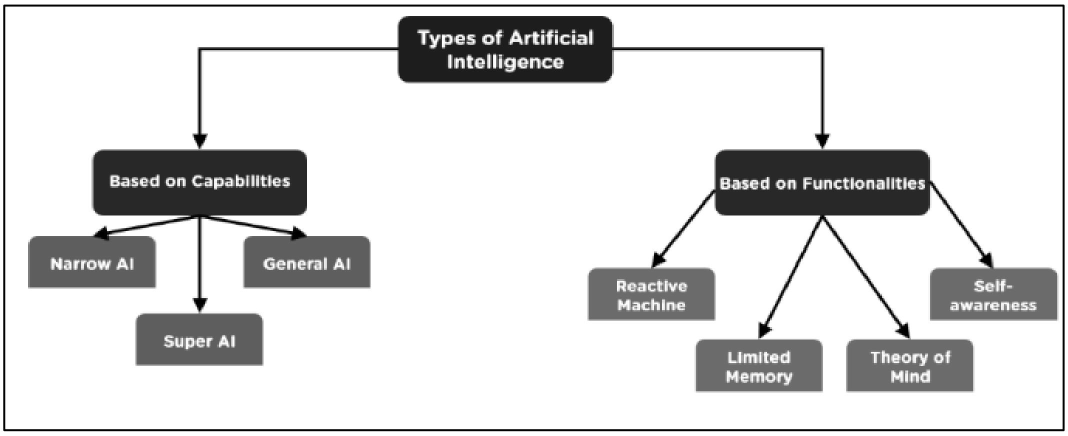

Figure 3: Types of Artificial Intelligence

Machines Learn to Diagnose:

Machine Learning algorithms can learn to see patterns similarly to the way doctors see them. A key difference is that algorithms need a lot of concrete examples – many thousands – in order to learn. So, Machine Learning is particularly helpful in areas where the diagnostic information a doctor examines is already digitized.

Such as:

- Detecting lung cancer or strokes based on CT scans
- Assessing the risk of sudden cardiac death or other heart diseases based on electrocardiograms and cardiac MRI images

- Classifying skin lesions in skin images
- Finding indicators of diabetic retinopathy in eye images

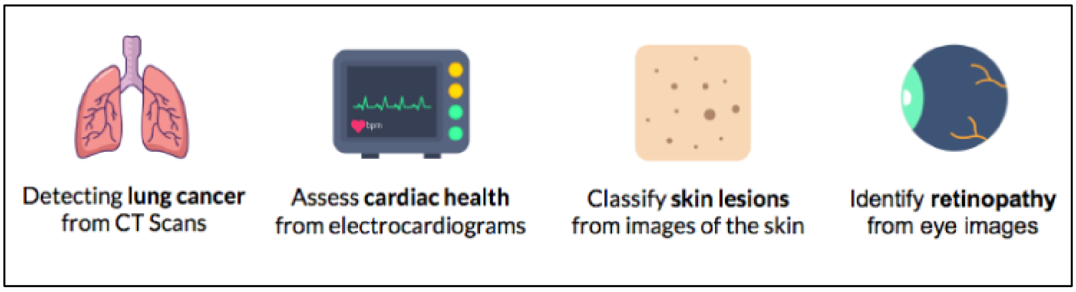

Figure 4: Machines Learn to Diagnose (Source: Google.Com)

Since there is plenty of good data available in these cases, algorithms are becoming just as good at diagnostics as the experts. The difference is: the algorithm can draw conclusions in a fraction of a second, and it can be reproduced inexpensively all over the world. Soon everyone, everywhere could have access to the same quality of top expert in radiology diagnostics, and for a low price.

As shown in Figure 5, the number of papers reviewed under preferred reporting items for systematic reviews and Meta-Analysis (PRISMA) guidelines for different types of diseases using AI from the year 2009 to the year 2020. The present work emphasizes various diseases and their diagnostics measures using machine and deep learning classifications. To the best of our knowledge, most of the past work focused on disease diagnostics for one or two disease prediction systems. Hence, the present study explores ten different disease symptoms and their detection using AI techniques. Furthermore, this paper is unique, as it contains an elaborate discussion about various disease diagnoses and predictions based upon the extensive survey conducted for detection methods.

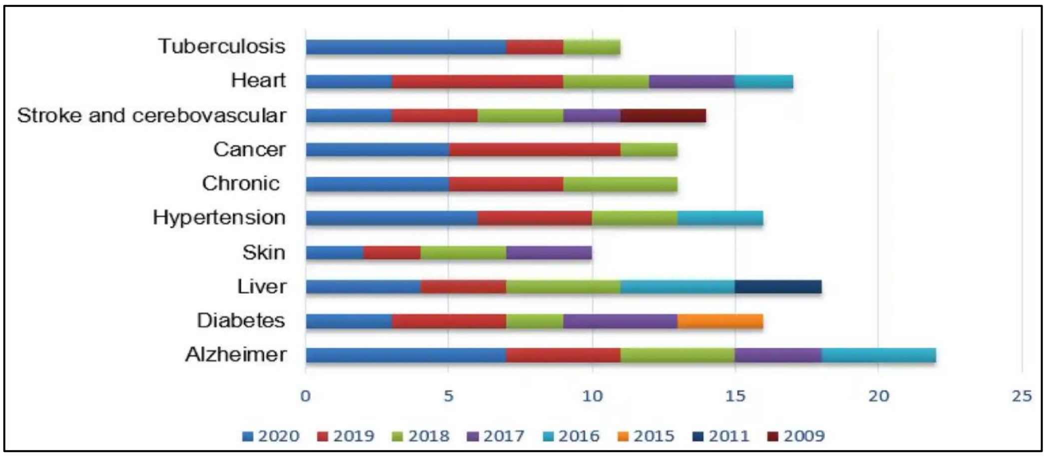

Figure 5: Diseases diagnosis using artificial intelligence techniques (Source: Springer.com)

Enhancing Image Analysis: AI in Radiology and Pathology Diagnostics:

Artificial intelligence (AI) holds a transformative potential in the field of radiology and pathology, where it is revolutionizing the way, we analyze medical images. Through machine learning algorithms and deep learning networks, AI can assist in interpreting a broad spectrum of diagnostic imaging – including X-rays, CT scans, MRIs, and pathology slides. These technologies go beyond human capabilities, analyzing images in minute detail, detecting abnormalities or patterns that can be easily overlooked by human eyes, and aiding in early detection and diagnosis of various conditions such as cancer, fractures, and neurological disorders.

In pathology, AI holds the promise to transform traditional microscopy. By digitizing slides and using AI algorithms to analyze them, we can streamline the diagnostic process and improve its accuracy. For instance, AI can be used to differentiate between various cell types, identify abnormal cell structures, and quantify biomarkers, helping pathologists make more informed decisions.

Improving Diagnostic Accuracy: The Role of Machine Learning:

The accuracy of diagnostic processes is fundamental to effective healthcare. Machine learning, a subset of AI, is playing a pivotal role in enhancing diagnostic accuracy across a wide spectrum of medical specialties. Machine learning algorithms, trained on vast datasets, can recognize patterns and anomalies within complex data that may be imperceptible to the human eye. These algorithms can aid in detecting conditions ranging from skin cancer to pneumonia in chest X-rays with impressive accuracy, often on par with or exceeding that of human clinicians.

AI in Telemedicine: Remote Diagnostics and Monitoring:

AI’s role in telemedicine has emerged as a crucial component of remote diagnostics and monitoring, especially in light of the recent global pandemic, which underscored the importance of healthcare accessibility irrespective of geographical location. With AI-powered tools, doctors can monitor patients’ health status remotely, analyze health data in real-time, and provide accurate diagnoses without the need for physical presence. [11]

Conclusion:

Artificial Intelligence refers to the broad spectrum of capabilities that machines are armed with to be able to perform tasks. Machine Learning is the defined subset of AI that lets machines learn by sifting and analyzing data. Machines get smarter as they achieve better capabilities using Neural Network, Deep Learning, Computer Vision and Natural Language Processing.

The healthcare sector is widely adopting artificial intelligence (AI)-powered solutions to obtain higher operational & functional results. This factor is supporting the growth of Artificial intelligence (AI) in the diagnostics market. Growing demand for advanced imaging methodologies for patient diagnostics is further driving market growth.

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